Examining the Post-3.11 "Demand Response"

How Japan Overcame the Power Crisis

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The Tight Post-3.11 Supply & Demand

The Fukushima Dai-ichi Nuclear Power Station, owned by the Tokyo Electric Power Company (TEPCO), suffered a severe accident in the wake of the Great East Japan Earthquake on March 11, 2011, which was comparable in its severity to the Chernobyl disaster in the former Soviet Union. I believe it is well-known worldwide, but there has not been much reporting overseas on the tight electricity supply and demand since the accident.

In the TEPCO service area, the Fukushima Dai-ichi and Dai-ni power stations were hit by the earthquake and the tsunami and remain out of commission to this day. At the same time, Hirono, Kashima, and other major fossil fuel power stations serving the region were also knocked out and failed to return online quickly. This caused massive supply shortfalls, leading to the first large-scale scheduled rolling blackouts in TEPCO's 60-year history. On March 18, 18 million out of its 29 million customers (on a contract basis) endured rolling blackouts.

Electricity demand in the Kanto area, served by TEPCO, peaks in summer, when consumption for air-conditioning rises. Although fossil fuel power units began returning online gradually, supply and demand tightened again in the summer, since nuclear power had accounted for a quarter of TEPCO's electricity output. The government responded by requiring large-scale electricity consumers in the TEPCO service area to reduce peak summertime demand by 15% from the 2011 level.

In Japan, a nuclear power plant must undergo regular inspections every 13 months and secure the consent of the local government before it can be reactivated. However, reactivating nuclear power plants proved exceedingly difficult, given the post-3.11 antinuclear mood prevailing nationwide, and the last of the 54 nuclear reactors shut down in May 2012. Japan had become a nation without nuclear power.

It was the Kansai region, consisting of Osaka, Hyogo, Kyoto and other prefectures in the neighborhood, that faced the most serious power crunch in the summer of 2012 as a result of the nuclear shutdown. The Kansai Electricity Power Company (KEPCO), which serves the region, normally relies on nuclear plants for half of its output, the highest proportion among the 10 Japanese utilities. KEPCO claimed that there would be a 20% shortfall without nuclear power when the summertime peak demand hit and argued for the reactivation of its nuclear power plants. The government responded by allowing two units at the Ohi Nuclear Power Station to come back online; by July, Japan was no longer without nuclear power. This still left a 10% shortfall in the supply-demand balance for the KEPCO service area. The government requested, not required, electricity consumers in the KEPCO service area to reduce consumption peaks by 10% or more and made preparations for scheduled rolling blackouts. As it turned out, there were no rolling blackouts, indeed no major confusion, in the Kansai region or anywhere else in Japan in the summer of 2012.

How did the Japanese people overcome these historical power shortages? I attribute it to "demand response". Demand response means changing electricity demand on the consumer side in response to the situation on the supply side. Balancing supply and demand for electricity is extremely important because of the need for real-time matching. This has been historically achieved unilaterally on the supply side through the possession of excess power generation capacity, as it was considered difficult to secure cooperation from the demand side. However, Japanese electricity consumers consciously changed their behavior when they faced the post-3.11 shortages.

Outcome of Demand Response

First, let's take a look at *Table 1*, which shows the peak cut in the TEPCO service area. Peak demand in post-disaster 2011 dropped 18% from the pre-disaster peak demand in 2010. Consequently, the TEPCO service area was able to avoid massive blackouts.

This was not just a one-off phenomenon on the day of peak demand. *Chart 1* tracks peak demand for every summer day (July 2 through Sept. 2) in the TEPCO service area. Average peak demand dropped from 51.32 gigawatts (GW) in 2010 to 40.89 GW in 2011. In other words, consumers in the Kanto region collectively achieved an average reduction of 20.3%. The average high temperature was 1.6 C lower in 2011 than in 2010, when it was exceptionally hot. But even after taking that into consideration, it is safe to say that a roughly

TABLE 1

Annual peak demand in TEPCO service area

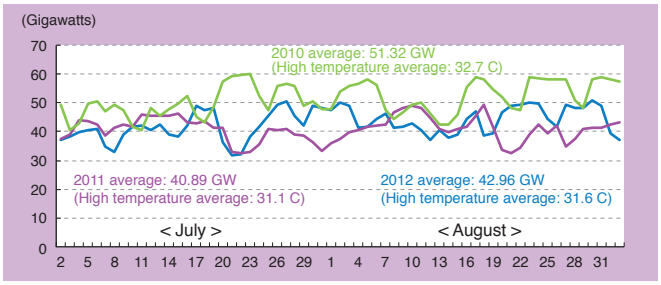
Date	2010 (July 23)	2011 (Aug. 18)	2012 (Aug. 30)
Peak load (gigawatts)	59.99	49.22	50.78
Reduction	(100%)	-18%	-15.4%
High temperature (C)	35.7	36.1	35.6

Note: Temperatures are for Tokyo and were taken from the Japan Meteorological Agency website. The true 2011 peak load was the 51.50 GW recorded on Feb. 14 before the disaster. It is very rare for peak electricity demand in Tokyo to be recorded in winter. This indicates that consumption volumes changed significantly as a consequence of the disaster.

Source: Compiled by author based on data from TEPCO website

CHART 1

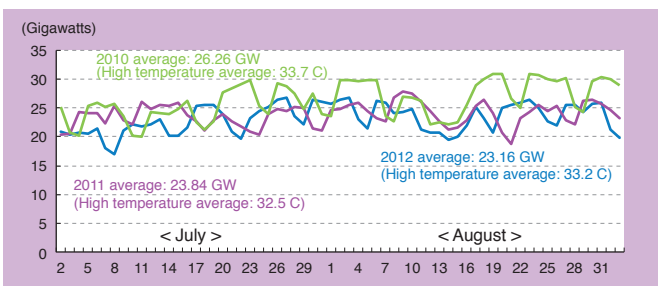
Summertime peak demand in TEPCO service area



Source: Compiled by author based on data from TEPCO website

CHART 2

Summertime peak demand in KEPCO service area



Source: Compiled by author based on data from KEPCO website

15% reduction in peak demand had been achieved.

All the data so far comes from the TEPCO service area. TEPCO was the culprit responsible for the Fukushima nuclear disaster, and its customers experienced rolling blackouts in March 2011. Some people may argue that this is why everyone continued to cooperate with sincerity and that this was a special, even exceptional, situation. However, similar epoch-making peak demand reduction also took place in the Kansai region.

Table 2 shows that the 2011 summertime peak demand in the Kansai region dropped 10.1% from 2010. This is only a little more than half of the reduction in the TEPCO service area, although it is still a significant amount. However, the reduction from the 2010 peak widened to 13.4% in 2012 — more than a year after the disaster — even though the high temperature was 1.1 C above the previous year. The reason for this was that the supply shortage in the Kansai region widened in 2012 and electricity consumers responded.

The Kansai region also shows this trend not only on the day of peak demand but throughout the summer. *Chart 2* shows that the average summer peak demand (July 2 through Sept. 2) in post-disaster 2011 dropped 9.2% from 2010. This margin widened to 11.8% in 2012. Although the Kansai region was not directly affected by the disaster, electricity consumers will come forward with demand response if they correctly understand the electricity shortage situation.

Details of Demand Response

How did the Japanese people execute demand response? Many

TABLE 2

Annual peak demand in KEPCO service area

Date	2010 (Aug. 19)	2011 (Aug. 9)	2012 (Aug. 3)
Peak load (gigawatts)	30.95	27.84	26.81
Reduction	(100%)	-10.1%	-13.4%
High temperature (C)	36.6	35.6	36.7

Note: Temperatures are for the city of Osaka and were taken from the Japan Meteorological Agency website.
Source: Compiled by author based on data from KEPCO website

offices and other facilities took measures such as raising the setting on air-conditioners to 28 C, reducing the number of lighting fixtures in use, switching to energy-efficient LED light bulbs, switching office computers to battery mode during peak demand afternoon hours, and reducing the number of elevators and escalators in use or turning them off entirely, according to an interview survey of businesses conducted by the Ministry of Economy, Trade and Industry and made public in the autumn of 2011. Efforts were also made to level the load by altering work patterns, such as encouraging "Cool Biz" light summer wear more thoroughly, staggering lunch breaks, and staggering days-off for summer vacations, which typically concentrate around the middle of August.

Demand response also reached the factory floor. Measures to reduce electricity consumption at the summer peak were taken, such as shifting factory operations to nighttime, alternating operation hours between businesses (in effect reducing operation hours), increasing production through June and meeting subsequent summertime demand with stock, increasing production in western Japan, where there were no electricity shortages, and even increasing overseas production. Automobile manufacturers drew a lot of attention when they executed drastic peak shifts by switching weekday production to the weekend.

Large factories made an immediate impact by operating private power generators full-time and installing new ones. Factories that require 24-hour continuous operation secured their own stable electricity supplies. When restrictions under the Electricity Business Act on sharing electricity within corporate groups were eased, some businesses used this to their advantage. The demand side cooperated in mitigating the peak load not only by reducing demand but also by increasing their own supply.

One reason why businesses worked on demand response was that they were eager to cooperate to stabilize electricity supply in light of the post-earthquake crisis looming over Japan. However, even more important was the fact that the government issued an order to restrict the use of electricity under Article 27 of the Electricity Business Act. This order imposed an across-the-board 15% reduction of peak demand on large-scale consumers with contract power of 500 kilowatts or more, backed with the strong enforcement power of fines on violators.

Households were not under any such obligations but cooperated willingly anyway when the government issued electricity conservation targets. Grassroots measures were taken everywhere such as reducing the use of air-conditioners and switching to electric

fans, opening and shutting refrigerator doors as infrequently as possible, putting TV sets in power saving mode, using rice cookers early in the morning to meet the needs for the entire day, and switching off the main power supplies for TV sets and other household electric appliances. The government and mass media cooperated in publicly sharing such knowhow.

Challenges in Demand Response

There were costs incurred by such demand response activities. Expenditures were required for fuel for private power generators, introducing electricity monitoring systems, and purchasing LED light bulbs, insulating film for windows, and pillows and mats made of cooling material and the like. Some businesses incurred total expenditures in the order of hundreds of millions of yen. Shifting production to nighttime and weekends increased labor costs, while sales opportunities were lost due to production cuts. Many people point to the significant psychological burden of executing such massive undertakings in such a short time.

Nevertheless, there were also positives alongside the costs. Most important was the reduction in electricity bills. The conventional wisdom had been that in the industrial sector in particular, Japan led the world in energy conservation and there was no further room for reducing energy consumption because it would be like "wringing water from a dry towel". However, it came to be recognized that there was still significant room for electricity conservation with proper attention, and electricity bills were visibly reduced. Knowhow was accumulated, such as the understanding that selective disabling of lighting met relatively little resistance but a similar reduction in operating elevators caused significant dissatisfaction.

Moreover, the private power generators and other investment costs were not insignificant, but they will be productive well into the future. LED light bulbs and insulating film do not wear out in a single year. This was why electricity conservation nearing 2011 levels was achieved in the TEPCO service area in 2012, as shown in *Chart 1*, even though it was hotter than in 2011 and yet no order to restrict the use of electricity was forthcoming, not even conservation targets.

If there was a source of major regret, it was the fact that the demand response was not always carried out in a smarter manner. Few Japanese households were equipped with smart meters, which meant that when and how much electricity should be and actually was conserved was not being made visible. Because of this, there were cases of "conservation through sacrifice" such as keeping air-conditioning idle during the night, where there was surplus power generation capacity.

Some businesses resorted to "conservation through sacrifice" that affected production even while others had further room for conservation. However, because there was no mechanism in place to exchange "negawatts", we cannot say that the coordination of supply and demand was executed efficiently. On the other hand, there were examples in the summer of 2012 where the lessons of the previous year were being used to some effect. There were cases in which electric utilities sent power shortage alerts to smartphones owned by individuals or executed demand response programs with help from outside service providers. Nevertheless, partly because the 2012 power supply wound up with a comfort margin, demand response programs were not used extensively.

Future Prospects

Thus, demand response corresponding to a power shortage has become the norm in post-3.11 Japan. Two nuclear reactors have been in operation since July 2012. However, more reactors cannot be expected to return to the grid anytime soon since the Nuclear Regulation Authority came into existence in September 2012 with a high degree of independence and began the process of establishing new safety standards. It has become inevitable for electricity consumers to cooperate through demand response since the power shortage will continue for the time being.

The government is also stepping up its efforts to promote this process. Ongoing talks aimed at reforming the existing rigid supplier-driven electricity system, which does not make use of market mechanisms or the power of networks, encompass the complete liberalization of retail markets and the separation of power generation and transmission. By taking such measures into practice, it is expected to facilitate further introduction of peak-shift pricing and demand response programs.

On the other hand the outlook for the government's long-term energy policy is becoming increasingly clouded. The Innovative Strategy for Energy and the Environment released on Sept. 14 seeks to "enable zero operation of nuclear power plants in the 2030s" but it is currently up in the air since there has been strong opposition from businesses and other quarters. The House of Representatives was dissolved at the time of writing, but if the Liberal Democratic Party, which had long been responsible for energy policy including nuclear power, returns to power it is likely that there will be another change in the direction of the reform of the electricity system.

That said, it appears unavoidable that tight supply and demand will continue for the mid- to long-term, and a return to the pre-3.11 situation of excess supply is almost unthinkable. Even if there is an easing of the shortage, a demand response that lowers electricity bills should become firmly established going forward. That is because the people's attitude towards consumption behavior has been dramatically changed through the post-3.11 experience and also because it is desirable to reduce energy consumption from energy security and global environment perspectives.

Demand response and smart grids have been gaining attention in recent years, in Europe due to the threat that the introduction of large volumes of renewable energy sources to the electric power system will result in its destabilization and in the United States because of the Obama administration's Green New Deal policy. A wide variety of field tests are being conducted worldwide, but no country has a more urgent need for demand response than Japan. Let's keep an eye on the Japanese people to see if they can open up new frontiers in demand response and use these to create business opportunities overseas, and whether policies can be put in place to accelerate this process. JS

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